

## Re-Description of the Jervis Bay Tree Frog *Litoria jervisiensis* ((Anura: Hylidae), with notes on the identity of Krefft's Frog (*Litoria krefftii*))

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### ABSTRACT

The holotype of *Litoria jervisiensis* (Duméril and Bibron) was examined in order to re-establish the identity of this species. *L. jervisiensis sensu stricto* (Duméril and Bibron) is a *Litoria ewingi*-like frog that occurs along the coastal fringes of New South Wales and is unusual in that it is a winter breeding species. The specific name of *jervisiensis* has been misapplied in the literature to refer to a hitherto undescribed species of *Litoria*, and which is not *ewingi*-like.

The holotype of *Litoria krefftii* Günther was also examined. The authors regard this specimen as being an unusually large example of *L. jervisiensis sensu stricto*.

### INTRODUCTION

Re-description of *Litoria jervisiensis* (Duméril and Bibron, 1841) is desirable in view of the current and past uncertainty regarding its status. The common name, the Jervis Bay Tree Frog, has been used in the literature to refer to a hitherto undescribed *Litoria*, and the specific name of *jervisiensis* is often mistakenly applied to this species. Barker and Grigg (1978) follow this usage of the common name in their interpretation of the species. The undescribed species will be referred to throughout this paper as the 'Heath Frog'. As further evidence of the uncertainty of the nature of *L. jervisiensis*, Cogger (1975, see fig. 295) includes a photograph of *jervisiensis sensu stricto* (Duméril and Bibron) and identifies it as *L. ewingi*. Martin and Littlejohn (1966) present information on the breeding biology of a species of frog which they refer to as *L. jervisiensis* but which in fact is the 'Heath Frog'.

Thus the identity of *Litoria jervisiensis* has become confused with time. Clarification of this species, as well as that of the Heath Frog can only be made

after a re-examination of the holotype of *L. jervisiensis*. A description of the Heath Frog is currently being prepared by the authors.

The holotype of *Litoria krefftii* (Günther) has also been examined because of repeated speculation (e.g. by Loveridge 1935, Moore 1961) about the validity of this species and its relationship with *L. jervisiensis*.

## MATERIALS AND METHODS

Specimen material was provided by the following institutions which are abbreviated below: AM Australian Museum, Sydney; QM Queensland Museum, Brisbane; ANWC Australian National Wildlife Collection, Canberra; CCAE Canberra College of Advanced Education, Canberra; and NMV National Museum of Victoria, Melbourne.

Measurements of all specimens were recorded to the nearest 0.1 mm using dial calipers. The measurements taken were snout-vent length (S-V), the distance from the tip of the snout to the posterior margin of the cloacal aperture; head length (HL), the distance between the anterior tip of the snout and the posterior extremity of the tympanic annulus; head width (HW), the maximum breadth of the head; eye-naris distance (E-N), the distance between the anterior edge of the eye and the naris; internarial span (IN), distance between the nares; eye diameter (ED), the horizontal diameter of the eye; tympanum diameter (TD), the horizontal diameter of the tympanum; and tibia length (TL), the maximum length of the tibio-fibula.

Mating calls were recorded on an Akai reel to reel tape recorder (model xv). The calls were analysed using a sound spectrograph (Sona Graph 6061B, Kay Electronics Co. U.S.A.), and chart recordings were prepared on a Fernbedienung Chart Recorder Type F-NB. Wet bulb temperature readings were taken in the field at the time when sound recordings were being gathered.

*In vitro* crosses were made in accordance with the techniques of Watson (1977). Control (or intertaxon) crosses were made to assess the normal survival rate of fertilised eggs. Male and female *L. jervisiensis* were collected at the Caves Beach Reserve in 1969. Male Heath Frogs were collected in the same year from an area six miles south-west of Robertson in N.S.W. and male *L. verreauxi* from an area 2½ miles north-west of Nowra, N.S.W.

## RESULTS

### RE-DESCRIPTION OF THE HOLOTYPE OF LITORIA JERVISIENSIS

*Hyla jervisiensis* Duméril and Bibron 1841, *Erpét. gén.*, 8: 580. Holotype: Muséum National d'Histoire Naturelle 4826 from Jervis Bay, New South Wales.

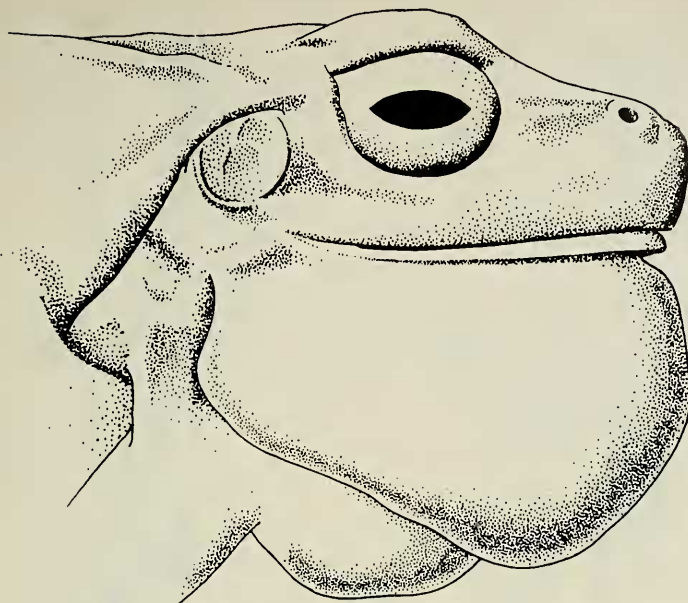


Fig. 1. Right profile of the holotype of *L. jervisiensis*.

The holotype was collected by Péron and Leseur during their travels through the southern regions of New South Wales. It is a medium sized frog (S-V 41.0 mm), slender body form, but with a relatively broad head (HL:HW 0.984). The head accounts for about one third of the total body length (HL:S-V 0.375). The snout is rounded in both dorsal and lateral aspects and projects very slightly beyond the line of the lower jaw (Fig. 1). The distance from the eye to the naris is greater than the internarial span (E-N:IN 1.167) and gives the snout a slightly elongate appearance. The nares are positioned high on the snout and are angled outwards and upwards. The eyes do not bulge above the line of the head and as a result the head appears to be flat. Nevertheless, the eyes are large, their diameters being larger than the eye-naris distance (E-N:ED 0.761). The tympanum is much smaller and less conspicuous than the eye (TD:ED 0.434) and is separated from the eye by a distance of 1.5 mm. The canthus rostralis is distinct and appears to be slightly concave when viewed from above. There is a prominent supratympanic fold which terminates near the axilla. The angle of the jaw bears a raised glandular line that still retains some traces of white colouration.

The fingers and toes possess well-developed terminal discs, especially on the more medial digits. The discs on fingers two and three are almost twice as wide as the tip of the finger. Fingers are free of webbing and the hand bears a few well developed subarticular tubercles (Fig. 2). The fingers are, in order of length



Fig. 2. Undersurface of the right hand of holotype of *L. jervisiensis*.

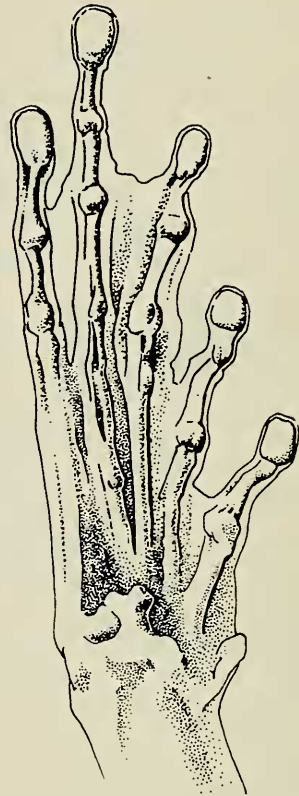


Fig. 3. Undersurface of the right foot of the holotype of *L. jervisiensis*.

4<3<1<2. Along the ventral margin of the forearm is a line of raised lumps that ends at the wrist.

The hind limbs are long and slender (TL:S-V 0.510). Webbing between the toes is extensive and reaches the discs of all the toes except the fourth where it extends as far as the base of the penultimate phalanx (Fig. 3). The toes are, in order of length, 1<2<3<5<4. There is a prominent, elongate inner metatarsal tubercle and a tiny outer metatarsal tubercle.

The vomerine teeth are small and situated in line with the anterior edges of the choanae. They are crescent-shaped and spaced well apart.

*Dimensions* (mm):—

External measurements: S-V 41.0 (note, this is 2 millimetres less than the original measurement taken by Duméril and Bibron); TL, 18.1; HL, 12.3; HW, 12.5; E-N, 3.5; IN, 3.0; ED, 4.6; TD, 2.0.



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### SPECIMENS EXAMINED

All the available specimens were collected from New South Wales. AM R27681-2, Woodford Island, Clarence R., 31.viii.1964; AM R29903, Baulkham Hills, 5.ix.1974; AM R73327, Centennial Park, Sydney, 12.vi.1978; AM R73328-33, Centennial Park, Sydney, 12.ix.1978; AM R74936, Lorne State Forest, Taree, 1.vi.1978; AM R78792-6, Smith's Lake, 30.viii.1972; AM R81666-7, Centennial Park, Sydney, 20.vi.1978; AM R81668, Mount Royal State Forest, Singleton, 22.xi.1979; QM J34222, Heathcote, —.i.1962; ANWC A0451, Batehaven, 20.i.1976; ANWC A0690, Ryan's Swamp, Caves Beach, Jervis Bay, 29.iv.1976; ANWC A1252, Ryan's Swamp, Caves Beach, Jervis Bay, 27.iv.1977; CCAE 206-11, Ryan's Swamp, Caves Beach, Jervis Bay, —.vi.1974; CCAE 216, Ryan's Swamp, Caves Beach, Jervis Bay, —.iv.1974; CCAE 265-9, Ryan's Swamp, Caves Beach, Jervis Bay, —.v.1974; NMV D6678-9, Botany Bay, pre 1877; NMV D7021, Sydney, no date.

### COMPARISON WITH OTHER SPECIES

*Litoria jervisiensis sensu stricto* (Duméril and Bibron) is considered by the authors to be most closely related to frogs of the *Litoria ewingi* group (as referred to by Tyler and Davies 1978) and should be included within that group. This judgement is made on the basis of comparative external morphology and head shape. Table 1 lists the comparative measurements of head and body proportions of three species from the *L. ewingi* group and the Heath Frog.

The Heath Frog is not closely related to frogs of the *L. ewingi* group and can be quickly separated from these frogs on the basis of head shape. Frogs from the *L. ewingi* group have heads that are longer than they are broad. The Heath Frog has a head that is broader than it is long.

### COLOURATION OF LIVE SPECIMENS

Most specimens are known from areas adjacent to Sydney, N.S.W. and therefore may not be completely representative of the colour patterns throughout the range of the species. The only noted difference in colouration between the Sydney specimens and other specimens is that the former have an intense yellow patch around the axilla (Plate 1a). Generally, the dorsal surface is smooth and two-toned brown in colour. The darker brown forms a broad, unbroken, vertebral band which becomes indistinct towards the posterior of the animal. The intensity of this band is variable and is sometimes difficult to discern from the rest of the dorsal pattern. The limb undersurfaces and ventral surface of the body are off-white in colour. The axilla and groin are yellow in colour, whereas the posterior of the thigh has a broad orange patch (Plate 1b). There are no spots or marbling in the groin or on the flanks. The specimen from Singleton is unusual in that there was a trace of orange in the crease of the groin.

CAPTION FOR PLATE 1 A AND B OPPOSITE

Plate 1(a). Adult male *L. jervisiensis* captured in Centennial Park, Sydney. This specimen has a marked white labial stripe and yellow patches about the axilla.

Plate 1 (b). Posterior view of an adult specimen of *L. jervisiensis* showing broad oval orange patches on the hind side of the thighs. There is no distinctive dorsal pattern.



Plate 1 a & b



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There is a faint white stripe along the upper labium, beginning in front of the eye, running beneath the tympanum and terminating at the axilla. The canthus rostralis is edged in brown. There is an ill-defined white band along the side of the head which runs from the posterior margin of the eye, above the tympanum and terminating above the axilla.

### COLOURATION AFTER PRESERVATION

The dorsal brown colour fades to a monotone grey leaving no trace of any back pattern. The tympanic stripe dulls and disappears altogether. The white labial stripe is dulled but seems to remain in the region of the glandular elevation at the angle of the jaw. The yellow patches around the axilla and hind limbs fade completely. Similarly the orange patch on the posterior of the thigh disappears leaving a blank oval patch. The entire undersurface assumes a grey or off-white colour. The throat sometimes retains some dark pigmentation.

### VARIATION

Adult snout-vent lengths range from 29.2-41.3 mm (see Table 1 for a comparison of the snout-vent lengths of other species within the *L. ewingi* group). From the specimens examined there did not appear to be a marked dimorphism in size between the sexes. The largest specimen that was examined was a male (ANWC A1252). All other species from the *L. ewingi* group show a distinct dimorphism in size between the sexes. Specimens AM R73327, AM R73328, AM R74936, AM R78792-5 and QM J34222 have nuptial pads. No gravid females were examined.

### DISTRIBUTION

The localities so far investigated indicate that the species is confined strictly to coastal N.S.W. Specimens are known from Ballina, in the north, to Twofold Bay in the south. A solitary specimen from the Hunter Valley, near Singleton in N.S.W. is the most inland example collected to date. This is also the highest altitudinal record. As already indicated this specimen was slightly different in its markings. Fig. 4 shows the sites of capture of *L. jervisiensis*. Specimens from

TABLE 1  
Adult Body Length Measurements and Proportions of Five Species of Frogs.

Species	S-V	TL:S-V	HL:HW	HL:S-V	HW:S-V	IN:E-N	IN:HW	ED:TD
<i>L. krefftii</i>	43.6	0.51	1.02	0.30	0.29	0.97	0.25	1.8
Heath Frog	40.1-67.0	0.51-0.61	0.83-0.98	0.30-0.37	0.31-0.38	0.78-0.93	0.21-0.28	1.6-2.4
<i>L. jervisiensis</i>	29.2-41.3	0.44-0.54	1.01-1.09	0.29-0.35	0.28-0.33	0.85-0.96	0.24-0.28	0.9-1.7
<i>L. ewingi</i>	22.5-42.5	0.50-0.56	1.01-1.07	0.30-0.37	0.29-0.36	0.73-0.90	0.21-0.25	1.0-1.5
<i>L. v. verreauxi</i>	26.3-37.7	0.34-0.53	0.94-1.01	0.28-0.35	0.28-0.35	0.86-1.00	0.25-0.30	1.4-2.2



Jervis Bay southwards were collected by Mr. K. R. Slater of the Canberra College of Advanced Education and are verified localities. It seems most probable that the range will be extended into Victoria with further collecting, especially around Lakes Entrance. Extensions of the range northwards are less likely because of unsuitability of terrain.



Fig. 4. Known localities of positive sightings or capture of *L. jervisiensis*.

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## PREFERRED HABITAT

All specimens, with the exception of the Singleton frog, are from low altitudes. The preferred habitat seems to be still ponds, fresh water swamps or fresh water lagoons. All of these need to be of a relatively permanent nature. The critical factor at all of these sites is the presence of thick stands of emergent vegetation such as *Typha* and *Eleocharis*. In the Centennial Park system in Sydney, only one of several ponds is used by *L. jervisiensis*. This pond is away from the heavily used recreational areas of the park and as such has not been cleared. Male *L. jervisiensis* use *Eleocharis* in shallow water or *Eryngium* on the edge of the pond as calling sites. In other localities males have been observed calling from

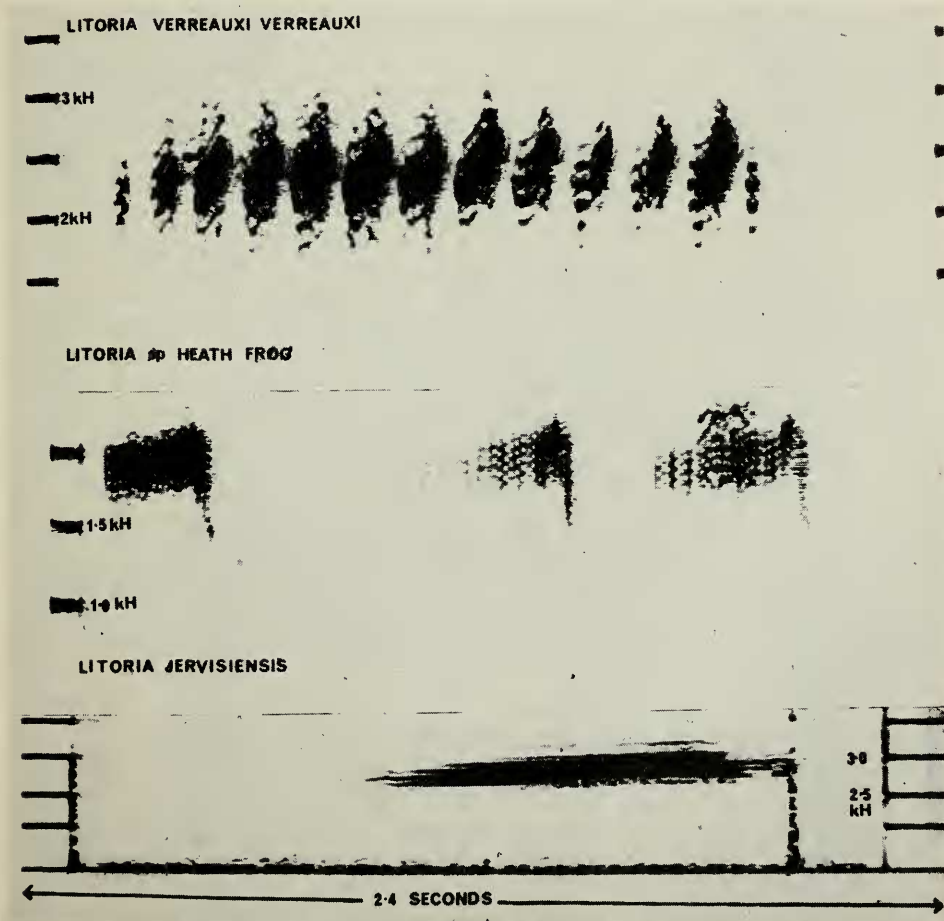


Fig. 5. Sonagram recordings of the mating calls of *L. jervisiensis*; *L. v. verreauxi* and Heath Frog.

LITORIA VERREAUXI VERREAUXI

01 02 03 04 05 06 07 08 09 1.0 15 20

LITORIA JERVISIENSIS

01 02 03 04 05 06 07

Fig. 6. Chart recording of the call of *L. v. verreauxi* and *L. jervisiensis*.

*Typha* These plants are utilised as refuge sites from predatory birds and are probably the sites for the deposition of eggs.

#### MATING CALL

Special attention has been placed on gaining a selection of recordings of the mating calls of *L. jervisiensis* and comparing the structure of the call with that of other closely related species that are sympatric in the Sydney area (i.e. Heath Frog and *Litoria verreauxi*). Call data for the Heath Frog is taken from Martin and Littlejohn (1966) and from the prepared recordings of Grigg and Barker (1973).

Samples of the sonagrams and chart recordings are presented in Figs. 5 and 6 respectively. Each call was analysed and the relevant data presented in Table 2.

#### ***L. jervisiensis***

The mating call of *L. jervisiensis* consists generally of 2 or 3 high pitched squeals, whose frequency ranges from 1980-2831 Hz (dominant frequency 2750 Hz) and which are repeated regularly after a short (c. 20 second) interval. Both call and note duration are short, the total call lasting on an average about 2 seconds. Each note rises in intensity as each note is produced (Figs. 5 and 6).

#### ***L. verreauxi***

The mating call of male *verreauxi* is unlike the other two species of frog considered. Each call is made up of 12 to 15 very short notes which tend to fuse to produce a pulsating whistle. The pitch is generally lower than that of *jervisiensis* with a dominant frequency of 2400 Hz and a range of frequencies between 1950-2800 Hz. Call duration, although made up of many notes, is short with the total call lasting about  $2\frac{1}{2}$  seconds.

#### **Heath Frog**

The distinctiveness of the call of this frog (and the above two species) reinforces the differences between these species. The call in this case is composed of between 6 and 14 notes, each note being a low drawn out sound. The pitch ranges from 1600-2100 Hz with a dominant frequency of about 1800 Hz (table 2). The recordings made at Darkes Forest (Fig. 5) show a downwards deflection in tone at the end of each note. This has not been noted in the call of Heath Frogs from other areas.

Pulse repetition rate has been used as a discriminating factor in the differentiation of frog calls between closely related species (Loftus-Hills and Littlejohn, 1971). The pulse repetition rates of *L. jervisiensis* and *L. v. verreauxi* do overlap (Table 2) while note duration and the number of notes per call are markedly different.

#### BREEDING SEASONS

Sustained observations have been kept on two populations of *L. jervisiensis* close to Sydney; one at Erina, near Gosford, N.S.W. (Dankers 1977) and the



TABLE 2  
Analysis of the Mating Calls of *L. v. verreuxi*, *L. jervisiensis* and the Heath Frog. Ranges given in parenthesis.

Species	Call Duration (secs.)	Notes per Call	Note Repetition Rate	Note Duration (secs.)	Pulse Repetition Rate	Dominant Frequency (Hertz)
Heath Frog Rec'd 24-viii-63; Cann R. Martin and Littlejohn (1966) Wet bulb 8°C	9.1 (6.0-12.3)	10.7 (7-14)	70.5 (68.3-73.3)	0.67 (0.64-0.70)	38.5 (37.5-39.4)	1683 (1600-1750)
Heath Frog Rec'd 21-xi-72; Darkes Forest. Grigg and Barker (1973-track 17)	7.8 (7.0-8.8)	8.0 (6-10)	63.8 (61.5-66.4)	0.62 (0.50-0.65)	—	1800 (1600-2100)
<i>L. v. verreuxi</i> Rec'd 14-ii-73; Palmdale. Grigg and Barker (1973- track 16)	2.53 (1.9-3.0)	13.3 (12-15)	315.4 (254-378)	0.07 (0.06-0.08)	112.4 (103.6-118.4)	2400 (1950-2800)
<i>L. jervisiensis</i> Rec'd 27-v-78; Centennial Park Wet bulb 10°C	2.10 (1.4-2.5)	2.3 (1-4)	85.7 (75-118)	0.70 (0.5-0.8)	119.7 (90.0-152.5)	2750 (1980-2831)

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other at Centennial Park by the authors. The Erina populations commenced calling in mid April in 1974 and continued calling until mid October. The males ceased calling in 1973 by the end of September. In Centennial Park in 1978 the pattern was the same; calling commenced in early April and continued until late October. However, for 3 weeks during the coldest part of winter (21.vi.78-18.vii.78) calling was interrupted, resuming once the air and water temperature had warmed a little. The critical temperature seemed to be at a wet bulb reading of 6°C. Below this there was no calling by the males. Wet bulb measurements were taken as these are more equatable to frog body temperature than dry bulb readings. Calling and reproductive activity was greatest in the pre-winter period.

TABLE 3

Seasonal Calling Patterns of Three Species of Tree Frogs. "+" indicates calling in that month.

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Heath Frog	+	+	+	+/-	-	-	-	-	-	-	+	+
<i>L. jervisiensis</i>	-	-	-	-/+	+	+	+	+	+	+/-	-	-
<i>L. v. verreauxi</i>	+	+	+	+	+	+	+	+	+	+	+	+

Temperature also altered the structure of the call of the male frogs. At low temperatures (6.0-7.5°C wet bulb) the call changed, the pitch was lower and the number of notes was reduced to one or two.

Elsewhere around Sydney *L. v. verreauxi* can be heard calling on occasions during every month of the year. The Heath Frog has a distinct summer peak in calling activity and does not call during the wintertime. Thus the opportunity for hybridisation between the Heath Frog and *L. jervisiensis* is restricted to a few weeks in April (Table 3). *L. v. verreauxi* has a breeding season which encompasses that of *jervisiensis* and the Heath Frog. Both *jervisiensis* and *verreauxi* occur in the same ponds at Erina but their respective calls are so distinctive that mis-identification of the mating calls by female frogs of these species is most unlikely.

## CALLING BEHAVIOUR

Observations on the preferred sites for calling by male *verreauxi* and *jervisiensis* show some behavioural differences. *L. v. verreauxi* has not been observed calling from water but does call from sites on the ground or in trees closeby. Male *L. jervisiensis*, on the other hand, prefers to call from emergent reeds. This behaviour has been noted by others (e.g. K. R. Slater; pers. comm.). The Heath Frog is less specific in its choice of calling sites and has been heard calling from low bushes, under ferns and in shallow pools. These differences in calling behaviour between the males of the three species serve to spatially separate the calling frogs according to their species.

## HYBRIDISATION TRIALS

*In vitro* cross-fertilisation studies were carried out to assess the innate compatibility of the three above mentioned species. Ova from female *L. v. verreauxi* and female Heath Frogs were not available when these trials were conducted. The crosses that were carried out are presented in Table 4.

TABLE 4

Cross-fertilisation trials between *L. jervisiensis*, *L. v. verreauxi* and the Heath Frog.

Male	Female	No. eggs	No. fertilised	% Hatched	% Abnormal
<i>jervisiensis</i>	<i>jervisiensis</i>	86	80	90	10 <sup>a</sup>
Heath Frog	<i>jervisiensis</i>	40	40	0	100 <sup>a</sup>
<i>verreauxi</i>	<i>jervisiensis</i>	34	34	0	79 <sup>a</sup> , 21 <sup>b</sup>

a Failed to develop beyond neurulation

b Failed to hatch

The information from these crosses demonstrates that hybrids cannot occur between female *L. jervisiensis* and male Heath Frogs or male *L. v. verreauxi*. The reverse may not be true. Clearly genetic barriers do exist between *L. jervisiensis* and the other two species and these barriers serve to reinforce confidence in *L. jervisiensis* as a biological species.

## KEY TO EWINGI GROUP AND THE HEATH FROG

This key is offered as a field guide and as such uses external anatomy and colouration of live specimens as discriminating characters.

1. Black spots or marbling in the groin ..... *L. v. verreauxi*  
     No spots or marbling in the groin ..... 2
2. White glandular stripe below the eye, always most prominent at the angle of the jaw ..... 3  
     No white glandular stripe below the eye, axilla and posterior of the thigh bright orange ..... Heath Frog
3. Axilla yellow, posterior of the thigh orange. Discs of the medial digits very much wider than the tip of the digit ..... *L. jervisiensis*  
     Axilla not brighter than the ventral colour, posterior of the thigh either yellow or orange. Discs on the medial digits as wide or slightly wider than the tips of the digit ..... 4
4. Canthus rostralis straight when viewed from above ..... *L. paraewingi*  
     Canthus rostralis concave when viewed from above ..... *L. ewingi*

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### NOTES ON THE IDENTITY OF KREFFT'S FROG

*Hyla krefftii* Gunther 1863, Ann. Mag. Nat. Hist. 11:28 Holotype: British Museum of Natural History 1947: 2.22.78, from Sydney, New South Wales.

The holotype was described 22 years after the naming of the *L. jervisiensis* type. Superficially it strongly resembled the *jervisiensis* type and has prompted speculation in the literature as to its specific identity. Loveridge (1935) argued that *krefftii* was a synonym of *jervisiensis*. His argument was based on the known distribution of *jervisiensis* and the fact that intensive investigation of the frog fauna around Sydney had failed to produce another individual that was similar to *krefftii*.

Copland (1957) noted the findings of Loveridge but did not appreciate that the frogs he had listed as *jervisiensis* were in fact a different species. Consequently he believed that *krefftii* and *jervisiensis* were different species. Moore (1961) used Copland's *jervisiensis* specimens as examples of that species, but also included specimens from the American Museum collection in his description of the species. Some of these specimens (Nos. 64029-64032) are *jervisiensis sensu stricto*. Moore did not query these or his other specimens but did include measurements from these frogs which showed that they were unlike the other specimens that he had included in *jervisiensis*. He furthermore presented measurements for both *jervisiensis* and *krefftii* types which reinforced the similarity between these frogs. He may have realised that there was an inconsistency in the taxonomy of these frogs but did not resolve these discrepancies.

The present authors have re-examined both type specimens. The *krefftii* type is a relatively large frog, larger in fact than the maximum recorded size for *L. jervisiensis* (Table 1). It is easily recognised by the presence of broad discs on the medial digits and relatively long tibia (TL:S-V 0.48). The fingers are free of webbing whereas the toes are extensively webbed, with all but the fourth toe being fully webbed. There is a glandular elevation at the angle of the jaw which still retains a trace of white pigmentation. The dorsal surface shows some evidence of a broad dorsal band but this has faded considerably. The vomerine teeth lie between the choanae.

On morphometric data the authors are impelled to agree with Loveridge, 1935 that *krefftii* is a synonym of *jervisiensis*. On the basis of HL:HW measurements (Table 1) *krefftii* is very similar to all of the other *ewingi* like frogs studied. On the basis of IN:E-N *krefftii* can be separated from all but *jervisiensis*. In fact the only character which might cast any doubt on its identity is its unusually large size.

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